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MOVING NEW VENTURE NEW PRODUCT DEVELOPMENT FROM INFORMATION PUSH TO PULL USING WEB 2.0

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ABSTRACT
With the rise of global competition, innovation through new ventures and products are seen as a vital part of industrialized nations' quest to sustain economic growth. An integral part of fostering continued innovation are improvements in the new product development and project management process - as research has shown that for new ventures these two areas are key factors for success. This rise of social networking, digital design tools, and virtual teams are setting the stage for a transformation in how products are developed. New product development has historically been a 'push system,' with individuals and teams transmitting information and waiting for feedback. We propose methods and tools that will leverage social networking and shift the paradigm of product development from a 'push' to a 'pull' system where communities can actively drive input to the project, rather than respond to active requests. This article proposes a collaborative Web 2.0 environment that will foster improved communication, design solutions, and innovation speed.

Keywords: product development, start-ups, virtual teams, e-collaboration

1 INTRODUCTION
At its basic level, innovation is "a process that begins with an idea, proceeds with the development of an invention, and results in the introduction of a new product, process or service to the marketplace" [1]. Schumpeter [2], one of the original contributors to innovation, outlined two types: 1) entrepreneurial innovation and 2) managed innovation. This article focuses on both aspects of innovation, and proposes methods of project management that may increase innovation through the benefits of social networking. The activity of new product development (NPD) is a *process* in which resources are committed to an entity whereby the finished product has a tangible value to the consumer. Doing something new or something known in a different way, is seen as the process of discovery and development that creates new products and services, production processes, organizations, technologies, and systemic arrangements [3]. The rise of the electronic collaboration is changing the way new ventures are organizing teams and executing innovation.

The NPD process is arguably the most important dynamic capability within a firm [4]. Taking the amount of resources companies spend on new product development and their short lifecycles into consideration, new product development is a risky proposition. In many cases, products have only six months to prove themselves in the marketplace [5]. Often, well-designed, innovative products fail, and this can have a serious impact on large firms let alone start-ups. Given the importance of early-stage firms on the economy and innovation, research into how NPD is performed at new ventures and optimal ways to manage that process better in the entrepreneurial context is unfortunately sparse. Historically, entrepreneurship research has instead concentrated on the entrepreneurial psyche, market strategy, founder experience, the industry environment of new firms, and the venture opportunity assessment process [6], [7], [8], [9], [10], [11]. Approaches to and successful outcomes from new product development are both by common sense and study one of the foundations for venture success [12].

Regardless of the age and size of the firm, research such as Cooper [13], [14], Griffin [15], and McGrath [16] focus on the high-level processes and structure of NPD. Their processes and methods are, while valuable, look at product development from the top down. Little focus is put on how to manage teams on a daily basis, e.g. methods for improving communication with vendors, computer-aided-design (CAD) drafting efficiency, etc. Balachandra and Friar [17] found that NPD is contextual, arguing that among different industries, technologies, and levels of innovation that the management process of NPD differs widely between sectors. We argue that NPD is also contextual in the manner it is studied. High-level process flows and management guidelines ignore what is occurring at the ground-level, on a daily basis, in teams developing innovative technologies and products. Bottom-up efficiencies are critical for project success, particularly in the new venture where resources are limited in manpower, time, and money. New ventures burn through precious capital daily, the need to facilitate team innovation for successful outcomes is paramount. It is in this area that this researched is focused. Can Web 2.0 technologies improve the design and development process in this space? In this paper, we propose a Web 2.0 application designed to foster design innovation and commercialization in new firms.

2 RESEARCH MOTIVATION

2.1 New product development and virtual teams

In new firms, the successful launch and commercialization of the first product has been shown to be critical to survival [18]. Given the high cost of product development and the failure rates associated with new product launches (40% of products and services fail according the Product Development and Management Association [19]), Cooper [13] outlines two fundamental aspects for mitigating the associated risks of commercializing successful products. These fundamentals are: 1) doing the *project right*, based on common success factors among successful NPD companies including cross-functional teams, up-front market planning, and early product concept definition; and 2) doing the *right projects*. Cooper argues that product selection and product planning methodology are essential to a successful product launch and lifecycle.

The important question to be asked is what do Cooper's fundamentals and associated 'methods and best practices' mean for the new venture? Our research has shown in several studies that NPD practices do have an impact on new venture product development and associated outcomes, but their implementation is unique. New ventures tend to adopt NPD best practices in a flexible a la carte fashion, eschewing onerous procedures for less resource intensive ones – increasing efficiency [20]. The act of NPD within the new venture is increasingly being performed by disparate contractor, vendors, and founders located globally.

In the light of de-centralization and globalization of work processes, many new ventures have responded to their dynamic environments by introducing virtual teams, in which members are geographically dispersed and coordinate their work mainly through electronic information and communication technologies. Over the last ten years, international cooperation has not only taken place in production, but to an increasing degree in the field of product and service development. Global competition, mass customization, and strong international collaborations on the international market are some of the trends that currently drive organizational changes and a rising value of virtual teams to develop innovation [21]. In the current atmosphere of increasing pressure to reduce costs, shortening time-to-market considerations, virtual teams can be a decisive factor to evolve innovation [22]. This is particularly important to the new venture that is resource constrained, in time, labor, and capital.

E-collaboration via virtual teams in NPD can provide a solution for iterative design and manufacturing activities that are performed by sharing and reusing information related to product development processes. E-collaboration tools for cross-border virtual teams in NPD may generate positive impacts such as shorter product development, error reductions, reuse of existing design, better cross-functional and cross-organizational cooperation, reduction of travel cost, etc. [23]. As a result, best practice in NPD is rapidly migrating from local cross-functional collaboration to a mode of global collaboration [24]. This is impactful for the start-up, as virtual team management and thus innovation effectiveness

needs to be as efficient as possible. In the next section, we review the transformation of information exchange and ramifications for the virtual team-based new venture.

3 INFORMATION PUSH TO PULL: TRANSFORMATIONAL TECHNOLOGIES AND SOCIAL NETWORKING

The integration of the Internet and e-collaboration, three-dimensional (3D) computer-aided-design (CAD), and a global network of suppliers and manufacturers has allowed companies to develop products at much faster rates using fewer resources and a virtual development team [25]. Virtual teams are able to quickly move from conceptual design into detailed design, fostered by the use of 3D CAD systems, which facilitates preliminary assessment of both production and use. Once 3D CAD is developed, designers are able to easily access a global network of suppliers for cost input that can ultimately direct design and iterative refinement [25]. MacCormack, et al. [26] note that in a flexible development process, changes to the evolving design can be made quickly and at low cost. Eppinger and Chitkara [24] state "a new paradigm has emerged whereby companies are utilizing skilled engineering teams dispersed around the world to develop products in a collaborative manner. Best practices in NPD are now rapidly migrating from local cross-functional collaboration to a mode of global collaboration." This global flexibility during development allows the virtual cross-functional team (CFT) - working within the NPD network using e-collaboration - to quickly change the product design based on feedback from suppliers, potential customers, and the testing of rapid prototypes [25]. However, while the benefits of virtual teams, e-collaboration, and the Internet have made great strides in NPD efficiency, the tools have allowed for efficient *transfer* of information. They have not changed the way information and knowledge is *processed* and *translated* into design improvements. Teams are sending information and receiving feedback in return. Regardless of whether it is mail, telegraph, phone, fax, or email, only the method of transfer has been updated. Obvious parallels can be drawn to personal communication. It is only recently that the act of communication has begun to change from active 'pushing' lines of communication, e.g. placing a phone call or transmitting CAD files, to pulling information in the form of social networking.

Social networking has its foundations in early computer communication. These included ARPANET, LISTSERV, and bulletin board services. During the growth of the World Wide Web in the 1990's, several Websites emerged that attempted to link disparate parties and foster improved communication and personal ties. By the 2005, MySpace and Facebook had emerged as leaders in the field[1]. Social networking sites are commonly referred to as Web 2.0 communities. The term Web 2.0 describes the changing trends in the use of Internet technology and Web design that aim to enhance creativity, communications, secure information sharing, collaboration and functionality of the Web. "Web 2.0 concepts have led to the development and evolution of Web culture communities and hosted services, such as social-networking sites, video sharing sites, wikis, blogs, and folksonomies[2]." In terms of communication and collaboration, sites such as Facebook have changed active *push* communication (e.g. one person sending an active email to another) to collaborative *pull* of feedback and interaction from an individual's circle of 'friends.' Information pull and feedback from postings can be passive from the larger community.

Concerning product development solutions, social networking, and the push and pull of information, we have developed a market space schematic. The schematic illustrates current product development solutions juxtaposed against the type of communication, labeled push or pull. Sites such as Facebook are considered information pull, while specific CAD programs, such as SolidWorks or PTC's Pro Engineer are noted as information push. Developing teams using software such as SolidWorks actively transmit files (e.g. sending files to obtain price quotes from potential vendors, etc.). In Figure 1, these type of product development tools fall to the upper left quadrant. Search engines such as Google, although they pull information from various sources are controlled and initiated by the user – we argue that the user is inputting – actively 'pushing' the information search, and getting a result. Social networking sites, such as Facebook, that allow the active and passive pulling of community communication and information are shown in the lower right-hand corner. In the middle section of

[1] http://en.wikipedia.org/wiki/Social_networking
[2] http://en.wikipedia.org/wiki/Web_2.0

Figure 1 clusters several project related Web sites and services. These include Basecamp® and Trac project management solutions. These wiki-based sites are primarily designed for general project management and have some limited capability to foster team communication in the development of physical products. However, these sites currently do not benefit from true Web 2.0 user interaction. They are essentially Web-based task lists, and have been historically used in software development projects. This proposal seeks to gain an understanding of the applicability of an information pull system working on mechatronic product development. This is shown in the upper right-hand corner of Figure 1. To the our knowledge, no known Web 2.0 site is currently functioning in this market space.

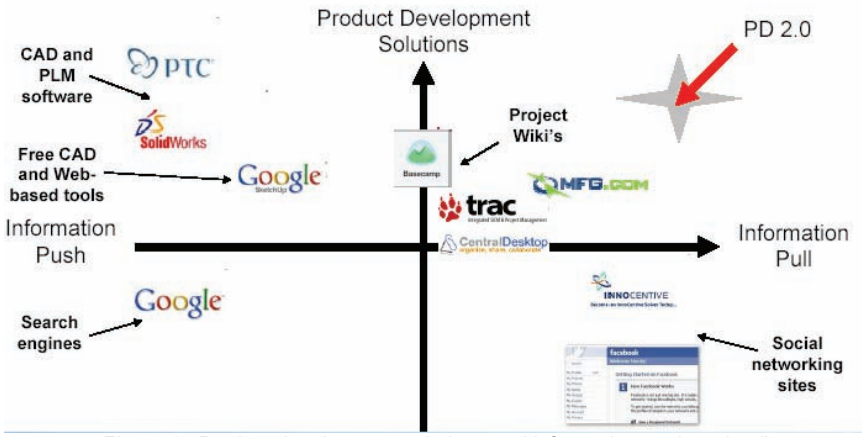

Figure 1. Product development solutions and information push and pull.

Is Web 2.0 applicable to new product development within the virtual team-based start-up environment? Given the schematic shown in Figure 1, we argue it is. Facebook has coalesced the transfer and feedback of email, instant messaging, picture storage and viewing, linking of individuals and groups, and daily management of friends and contacts – in essence the project related items of the maintenance and development of friendship and relationships. For traditional projects, there are already online project management sites such as Trac. These treat any development initiative, from software to services as a project. A project can be defined as a unique set of tasks with a beginning, an end, and a well-defined outcome [27], [28]. A new product development venture – be it a start-up or one that is part of an existing company - is project in the most classic sense, which starts with an idea, obtains funding, follows on agreed milestones, and ends through ongoing operations, closure, or a liquid event [28]. In relating project management steps to new ventures, the development initiative will go through a series of steps from idea to commercialization. Most likely, the start-up will need a team of experienced people to guide the project from idea to commercialization. A team can be defined as a group of people who participate in the product development project, adding different skills necessary to complete the project [29]. During the project, there will be a need to manage the project in a certain fashion, ensuring goals and milestones are met. This can include 'go/no-go' management decisions, formal project management practices, and the use of stage-gates. The new venture will need to understand, or try to predict the market and customer needs where possible using market research and assessment [14]. The product will need to be appealing, both aesthetically and in ease-of-use through the application of industrial design [30]. If the business is going to be sustainable, a series of product offerings will need to be introduced overtime thereby growing revenue via increased sales – by leveraging the firm's core technology and R&D into a series of platform-based products [31]. Finally, the project will need to be financially managed to ensure positive product margins and cash flow during development and after launch [32]. Regardless of the context of the development initiative, from start-ups to established technology firms, a new product development project clearly needs to be managed in order to draw the least amount of resources – funds, personnel, and timing. Communication will need to be efficient and effective. The sourcing of vendors and manufacturing will be to be efficient and effective. The ideation of concepts will need to efficient and effective. Finally, the knitting of these disparate facets of the project will be to be efficient and

effective. We have already seen the benefits of very limited Web-based project management solutions. Web 2.0 has the ability to be a step function improvement in communication, project efficiency, and coagulation of the project's disjointed elements – just as it has transformed the daily management of friendships and relationships for active users. This is particularly the case of new ventures development mechatronics.

Why mechatronics? Von Hippel [33] states that "hardware is becoming much more like software, up to the point where you actually start to fabricate an object. Product design is largely going to shift out from manufacturers to the communities." This research is designed to anticipate that trend and foster the beneficial impact on communal design. Mechatronics – technologies that are multi-disciplinary including mechanical, electrical, and software components that require iterative prototyping and the development of an extensive supply chain – are arguably the most complex type of product development. They include the physical manipulation of materials to form final shapes, and logical code to guide their operation. These types of products (i.e. the Apple iPhone) require input from a wide variety of disciplines, from mechanical engineering to computer science. Physical parts are designed, fabricated, and tested. Users act intimately with the product not only in a physical sense, but also in the transfer of digital information. Lastly, these products need to be funded, produced, and put in the hands of potential customers. The management of these different groups can be challenging, and are not well served by current research such as Cooper [13].[14] or Ulrich and Eppinger [30].

There are a number of issues with the way products are currently designed and readied for market commercialization. In no particular order, here are some of the important issues that inhibit product development efficiency – particularly within the new venture that does not have the resources to withstand costly inefficiencies.

- During development, engineers can often have a nearly endless series of CAD file revisions, all stored on a server. There are issues with:
    - Naming
    - Revision level
    - Finding files
    - Organization of new and old files
- PLM systems are not applicable to new ventures – their complexity and requirements for disciplined implementation and management are at odds with the fast moving new venture
- Project management is difficult:
    - Not enough time to use applications like Microsoft Project
    - Projects move and change too often and quickly for Gantt charts to be effective
    - Most project managers in new ventures just rely on lists, etc.
    - Allocating and binning design time per project is difficult, and not what the designer wants to do (not value added)
    - File servers need to be maintained
- Get quotes or costs on prototypes is a manual operation (active information push) that can be difficult and time consuming
- Client/investor input and updates on designs can often be time consuming for management (developing presentations, etc.).

Moving e-collaboration to the next level stands the chance of reducing or eliminating these sources of inefficiency. Social networking and a dedicated NPD application could be developed to enhance the positives of these disparate systems while eliminating the barriers that inhibit efficiency and effectiveness (the cons). In the next section, the application is proposed.

4 PROPOSED APPLCIATION: NEW PRODUCT DEVELOPMENT 2.0

This article proposes development of a collaborative Web 2.0 environment that will enhance several aspects of new product development and management. The software application will: 1) foster inter and intra-team communication, 2) handle product data storage and life cycle management issues, 3)

allow third-party vendor participation, 4) promote outside and/or public interaction with product concepts, and 5) gather data to increase knowledge of development team efficacy.

The system will consist of a main project page, which contains all the applicable sub applications necessary for product development within the new venture. A sample project page (termed *Product Space*) is shown in Figure 2.

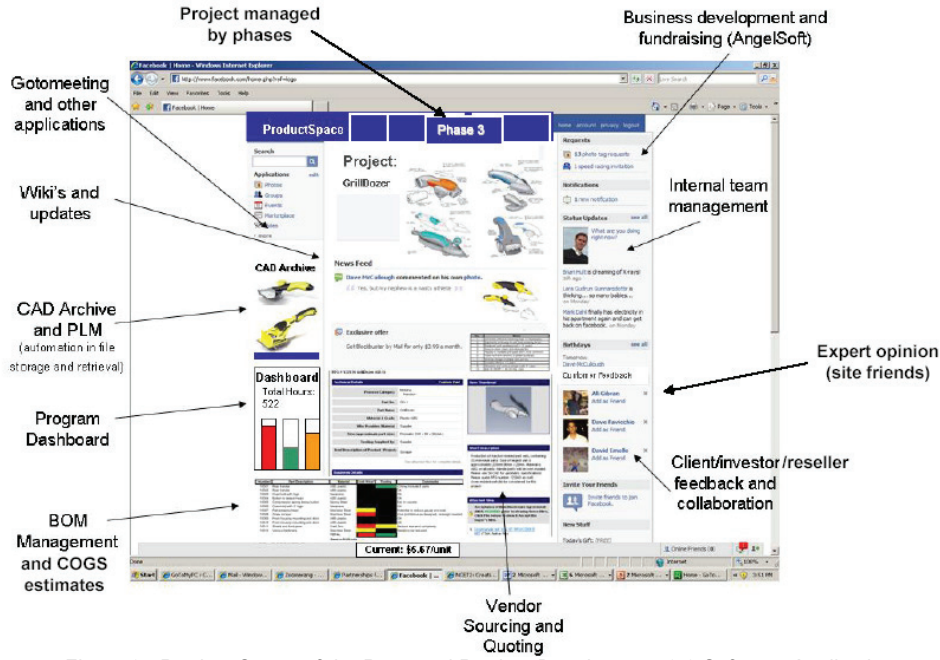

Figure 2. Product Space of the Proposed Product Development 2.0 Software Application.

This main project page will be at the intersection of three divergent trends in communication, design, and collaboration. These trends are the implementation of Product Lifecycle Management Software (PLM), project Wiki's, and Web 2.0 applications. The Product Space page is intended to be managed by phase. For example, during conceptual development, industrial design concepts can be shared and commented on by the virtual team. Concepts can be rated and selected by potential customers and investors. The internal management team can view progress on the project and add value-added feedback. In Figure 2, Phase 3 is shown, which in this example is a detailed design phase. This will include uploading and management of CAD files, bill-of-materials (BOM) management, program dashboards (projects hours spent to budget, etc.). In the proposed application, CAD files will be easily accessible by the team, and allows new ventures and virtual teams the pros of PLM (the organization and management of large CAD files and assemblies) without the cons (complexity and expense, diligence to maintain). Designs can be commented on by the team or outside potential customers and stakeholders.

Each Product Space page will have a Wiki element. Wiki's have been used for several years to allow collaboration of disparate, virtual teams. These mainly are used by software developers that can 'hand off' code to other developers, and keep the project running 'around the clock.' These project Wiki's are exemplified by software services such as Trac (http://trac.edgewall.org/) and PBWiki (www.pbwiki.com). In the proposed application, the Product Space allows one place for project specific information, and allows multiple users to add to project updates. While this ability is common to dedicated project management Wiki's, the proposed application differs in that it will allow large file sizes (CAD), and allows the new venture to create structure by project phases (conceptual, detailed design, product launch). For the start-up, there is certainly a need for balance in the strategic

management of the nascent firm between flexibility [34], structure, and process [35]. Product Space can add discipline, without adding innovation sapping procedures as recent research has shown that recent research has argued that rigorous processes can hurt the performance of novel new products [36].

Key to the new venture is cost management the proposed application allows prototype suppliers, manufacturing vendors, and investors to have accurate, up-to-date information not only on project costs, but also on unit pricing and tooling. Potential vendors can input comments on designs and also compete for pricing. Duverlie and Castelain [37] found that 70% of the ultimate costs of goods for a given new product are determined during the early-stages of that product's design. As such, it is imperative that firms track and base development decisions on these product and set-up costs. In order to accomplish this, firms have shifted to activity-based costing (ABC) systems that enable product designers to create products with lower indirect and support costs [38]. Planning carefully at the front-end of the design cycle can dramatically lower cost of goods – this application can aid in that endeavor. This type of social networking for product costs leverages the benefits of services like MFG.com (Web service quoting system for product pricing and tooling) into a new paradigm.

From industrial design iterations to costing unit pricing, social networking though a site like 'Product Space' has the ability to transform product development within new technology ventures. It increases structure and discipline (while maintaining flexibility), and allows the flow of information to migrate from active push to passive pull – effervescing project progress and communication. A Web 2.0 application line Product Space can dramatically increase networks of external relationships (from contractors to potential investors). Research has shown that a network of external relationships is an important factor in the development of a new firm. In a study of 60 firms, Lechner, et al. [39] showed that entrepreneurial networking is as much about adding new and different relationships as about transforming existing relationships. Web 2.0 social networking has the potential to accomplish this growth, while increasing innovation effectiveness and efficiency of the development process.

5 FUTURE RESEARCH

Given the national focus on innovation, business growth, and new product development, little research has been performed on maximizing the potential benefits of a Web 2.0 application on product development and project management for physical technology products. The proposed application will be a hub of interaction between disparate groups, increasing knowledge transfer and ultimately improving product and project performance by shifting the paradigm of product development from information push to pull. The research and application can have an immediate impact on universities and industry firms that development physical products. Efficacy of the method and how to validate it is essential to the future of the research project. Frey and Dym [40] have noted that medical validation techniques may have a substantial impact on validating engineering design methods, which will be considered in future research. After development of the application, two options for validating NPD 2.0 a are careful collection and analysis of natural field data as the process is introduced and used by different firms, and well defined 'clinical trials' when applicable. In order to accomplish this, we plan to raise funds to develop the site and have it available to universities and select new ventures. This will include free instructional materials for training students and professionals on the benefits of the approach.

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